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Any questions concerning the meetings should be addressed to the appropriate chairmen.

NEWS

1957 Program Plans——Employment Register Planned——Summer Statistical Seminars——Government Job Openings

Program Plans for 1957 Annual Meeting

The 1957 Annual Meeting of the American Statistical Association will be held in Atlantic City, N. J. September 10-13. The Biometric Society (ENAR), the Institute of Mathematical Statistics, and the Econometric Society (East Coast Region) will meet with the A.S.A.

A diverse program is planned by the Program Committee, which consists of representatives of each of the Sections of the Association, and Arnold J. King, chairman. The Business and Economic Statistics Section has developed sessions on methods of long-term and short-term forecasting, consumer demand and expenditures, seasonal measurement, the estimation of inventories and factors influencing inventory changes, and other sessions, as well as the customary luncheons on the stock market and the economic outlook. The Social Statistics Section has organized sessions on measurement errors in sample surveys, the identification of sub-standard levels of living, classification problems in sociology and psychology, agricultural statistics, testing hypotheses in evaluating social welfare programs, and other areas. The Biometrics Section, in cooperation with the Biometric Society (ENAR), will present sessions on tolerance limits, genetic statistics, objective yield forecasting, psychometric statistics, clinical and field trials in public health and medicine, stochastic processes in biology, and other subjects. The Section on Physical and Engineering Sciences has planned sessions on the exploration of response surfaces, fractional replication, life testing, non-parametric studies, problems of the earth sciences, and other areas. The Section on Training has organized sessions on university programs of engineering statistics, the statistical problems of agricultural experiment stations, and the supply of and demand for statisticians. In addition, there will be three sessions on computers, the Census Tract luncheon and meeting, an evening session which promises to present authoritative views of the role of the statistician in business and industry, and the Presidential Address.

The whole program is already well developed and should provide interesting and useful fare for all members of the Association. A tentative program, in detail, will appear in the next issue of THE AMERICAN STATISTICIAN.

B & E Statistics Section Session for Contributed Papers

The Business and Economic Statistics Section will have a session for contributed papers on its program for the Association's meeting in Atlantic City, September 10-13, 1957. Anyone wishing to contribute papers to this session is requested to contact Mr. Louis J. Paradiso, Program Chairman, Room 3850, Department of Commerce Building, Washington 25, D. C.

Employment Register at 1957 Annual Meeting

Warren H. Lutz, Chairman of the Employment Register Committee for the 1957 Annual Meetings, reports that negotiations with the United States Employment Service are in progress. While no final procedure has been worked out as yet, it seems likely that this year, as in the past, applications will be handled through the local State Employment Offices. A special Placement Booth will be operated at the Ambassador Hotel in Atlantic City during the meetings.

Detailed information on steps to be taken by members of the Association seeking employment or change in employment will probably be given in the next issue of THE AMERICAN STATISTICIAN.

Vote on Report of SPES Publication Committee

At the business meeting in Detroit, the Section on Physical and Engineering Sciences heard the report of the Publication Committee. Seventeen committee members, under the chairmanship of Professor E. G. Olds, considered the possibility of a separate journal for papers dealing with the application of statistics in the physical sciences.

The report stated that a majority of the members did not believe a new journal was now needed but recommended reconsideration after two years. The report suggested devoting one issue of JASA to SPES papers. A lively discussion of the topics taken up in the report led to a motion for a letter ballot on the question of accepting the report. The ballot also invited listing of published papers appropriate for a SPES journal and listing unpublished papers that encountered difficulty with existing journals. Ballots received: 226; Approve report: 191; Disapprove report: 30; not voting: 5. The table shows the number of ballots listing papers believed suitable for a SPES journal.

	Number of returns listing				
No. of papers	0	1	2	3	4 or more
Published	196	8	6	2	14
Unpublished	214	7	4	0	1

Cornell Industrial Engineering Seminars

The Department of Industrial and Engineering Administration, Sibley School of Mechanical Engineering, Cornell University is sponsoring a series of seminars from June 11 through June 14, 1957 at Cornell University. The following areas are to be covered: Industrial Management, Manufacturing Engineering, Small Plant Management, Methods Engineering, Applied Industrial Statistics, and Data Processing Systems. In addition there will be several general sessions for all participants. These seminars provide an opportunity for critical study

and reappraisal of some of the major problems of manufacturing planning and control. Discussion leaders and speakers will be drawn from both industry and the staff of Cornell University.

Additional information may be obtained from Andrew Schultz, Jr., Department of Industrial and Engineering Administration, Cornell University, Ithaca, N. Y.

Short Course for Research Workers
At North Carolina State College

The Institute of Statistics at North Carolina State College will sponsor a one-week intensive short course in Statistics Methods for research workers in industry and the physical sciences beginning the week of June 3. The course will be held at Brevard College in Brevard, North Carolina.

The course will be run in two sections—an elementary and an advanced. Lectures in the elementary section will cover basic concepts, confidence limits, tests of significance, correlation and curve fitting, analysis of variance, and an introduction to design of experiments. Among the topics included in the advanced section will be variance components, multiple regression, response surface methods, experimental design and analysis of organoleptic experiments.

A registration fee of $100 will be charged. Enrollment will be limited to 50 students in each section. For further information, write the Institute of Statistics, North Carolina State College, Box 5457, Raleigh, North Carolina.

Summer Statistical Seminar at Dedham, Mass.

(A preliminary announcement of this seminar was included on p. 5 of the February issue of THE AMERICAN STATISTICIAN under the title, "Plans for 1957 Seminar."

A two-week summer statistical seminar will be held at the Endicott House in Dedham, Massachusetts, beginning July 29, 1957. The first week will be devoted to the general topic of time series with emphasis on turbulence, aeronautics, ship motion, and communication, under the chairmanship of Leo Tick of New York University.

The program for the second week will include business applications, reliability, and data reduction topics, as part of the general discussion of the impact of computers on statistical problems. Dr. Max Woodbury is chairman of this program.

Further information can be obtained from Dr. M. E. Terry, Bell Telephone Laboratories, Murray Hill, New Jersey, or the secretary, Dr. Geoffrey Beall, Gillette Safety Razor Company, Boston, Massachusetts.

Summer Offerings in Statistics
At Iowa State College

The Department of Statistics at Iowa State College will offer six applied courses in statistical theory and methods in its two 1957 summer sessions. These courses are planned primarily for graduate students or research workers with limited mathematical backgrounds who wish to use statistical techniques intelligently for application to other fields. In addition, a course on special topics in theoretical or applied statistics may be studied at the graduate level. Senior staff members will be available during most of the summer for consultations on research or special problems.

Students may register for either or both of the six-week summer sessions: June 18 to July 24 and July 24 to August 30. The complete list of statistics offerings for the first session is as follows: Stat. 401, "Statistical Methods for Research Workers" (at the level of Snedecor's *Statistical Methods*); Stat. 447, "Statistical Theory for Research Workers" (mainly theory of experimental statistics); Stat. 599, "Special Topics;" and Stat. 699, "Research." In the second session will be offered Stat. 402, a continuation of 401; Stat. 448, a continuation of 447; two courses in applied methods which are more specialized—Stat. 411, "Experimental Designs for Research Workers," and Stat. 421, "Survey Designs for Research Workers;" and finally Stat. 599 and 699. Additional information may be obtained from T. A. Bancroft, department head and Director, Statistical Laboratory, Iowa State College.

Summer Sessions at Berkeley, California

The 1957 summer program in the Department of Statistics of the University of California, Berkeley, California, will consist of two sessions: June 17 to July 27 and July 29 to September 7. The faculty of the summer sessions will include Professor D. A. Edwards of Yale University, Dr. Walter L. Smith of the University of Cambridge, England, Dr. M. M. Brooke, Dr. W. J. Hall, Dr. R. E. Serfling and Dr. M. B. Willis of the Communicable Disease Center, Public Health Service, Atlanta, Georgia, Dr. Nathan Mantel of the National Institutes of Health, Bethesda, Maryland and Professors Evelyn Fix, J. Neyman and R. A. Wijsman of the Department of Statistics of the University of California, Berkeley.

The program includes two of the usual undergraduate courses in each session, adapted primarily to meet the needs of students transferring from other centers who would like to undertake advanced study at the University of California during the regular academic year. Also a research seminar in statistical problems of health will be conducted in close collaboration with the representatives of the Public Health Service and National Institutes of Health. The discussions will begin with the medico-biological side of the problem and will then be followed by the statistical treatment.

A New Department of Statistics at Harvard

The Harvard Faculty of Arts and Sciences voted on February 12 to establish a separate Department of Statistics, to begin officially on July 1, 1957. Further details will be carried in a forthcoming issue of THE AMERICAN STATISTICIAN.

Summer Institute in Survey Research Techniques

For the tenth consecutive year, the Survey Research Center of the University of Michigan will hold its Annual Summer Institute in Survey Research Techniques. This special program is designed to illustrate the theory and application of survey research to such fields as business and human relations, psychology and sociology, political behavior, public communication and influence, public health, economics, statistics, etc. Again this year a special workshop will be offered in the practical application of survey research methods to these individual fields.

The dates for the regular session are July 22 to August 17, with introductory courses offered from June 24 to July 19. Further information may be obtained from the Survey Research Center, University of Michigan, Ann Arbor, Michigan.

University of Chicago Department of Statistics

The department of statistics at the University of Chicago, known since its organization in 1949 as the Committee on Statistics, is now called the Department of Statistics. The name was changed from Committee to Department in order to avoid confusion about the nature and status of the organization.

Leonard J. Savage, who has been Acting Chairman of the Department this year, has accepted a regular appointment as Chairman beginning March 1, 1957. He succeeds W. Allen Wallis, who now is Dean of the School of Business though he continues as a member of this Department. Other members of the Statistics faculty are K. A. Brownlee, Kai Lai Chung, Sudhish G. Ghurye, Leo A. Goodman, William Kruskal, John W. Pratt, Harry V. Roberts, and David L. Wallace.

Job Opportunities

Several vacancies exist for Analytical and Mathematical Statisticians and Economists at Headquarters, Air Material Command, USAF, Wright-Patterson Air Force Base, Ohio. These positions are in the Logistics Research Division, and consist of challenging assignments in the fields of basic and applied research on problems of Air Force logistics. Starting salaries vary from $5,440 to $10,420 per year. Candidates should submit a resume of work experience and education directly to:

Central Civilian Personnel Office (MCGCE)
Headquarters, Air Material Command
Wright-Patterson Air Force Base, Ohio

The Air Force Institute of Technology, located at Wright-Patterson Air Force Base, Dayton, Ohio, has an opening for a teacher of statistics, work to begin not later than summer 1957. The position will carry a civil service rating of GS-11 or GS-12, depending upon the qualifications of the applicant, with a beginning salary of $6390 or $7570. Applicants should have a Ph.D. degree, and be qualified to teach elementary and advanced courses. Successful teaching experience is desirable.

The teaching load will be moderate and it is expected that some time will be devoted to research in order that courses taught may have the greatest possible applicability to the needs of our students. Duties extend over the entire twelve months but one quarter of each year is usually devoted to study and research. Students in the School of Business are Air Force officers with baccalaureate degrees in either Business Administration or some branch of Engineering who during their assignment as students at the Institute of Technology complete requirements for the degree of Master of Business Administration or Master of Engineering Administration.

Applications should be addressed to Dr. James Roy Jackson, Dean, School of Business, Air Force Institute of Technology, Wright-Patterson AFB, Ohio.

The Quartermaster Food and Container Institute at Chicago has a vacancy for a Chief Statistician at Grade GS-13 or 14, with an entrance salary of $8,990 or $10,320. Applicants with Ph.D. degrees in Statistics are preferred, though this is not an absolute requirement. They should have a thorough knowledge of modern mathematical and experimental statistics and the application of these techniques to practical problems. In addition, a knowledge of punched card and electronic computers and their application to statistical problems is desirable.

The Quartermaster Food and Container Institute is a Department of the Army activity with responsibility for research and development in foods and their containers for all the military services and for research and development in containers for other Quartermaster Corps items. The application of statistics will be in the fields of chemistry, nutrition, physics, engineering, psychology, biology, biophysics, biochemistry, and bacteriology, plus many combinations of the above. As necessary, the Chief Statistician also serves as mathematician for the Institute.

Inquiries should be directed to Donald K. Tressler, Scientific Director, Quartermaster Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Illinois.

The Bureau of Mines has openings for Mathematical Statisticians in its field offices. It will consider applicants for salary levels from $4,000 to $9,000, depending upon education and experience. Persons interested should write or contact R. C. Parmelee, Bureau of Mines, Washington 25, D. C., giving details of education, experience, salary wanted, and location preferences.

The 1955-56 Proceedings

OF THE

Business and Economic Statistics Section

OF THE

American Statistical Association

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FEDERAL STATISTICAL ACTIVITIES

Change in Definition of Labor Force Categories

The Bureau of the Census has announced that future estimates of employment and unemployment contained in the monthly releases of the Current Population Survey will reflect a modification of the definitions which have been in use since 1940. The change, which was adopted on recommendation of the Bureau of the Budget, is designed to make the monthly figures better reflect labor market conditions which exist today and to conform more nearly with the eligibility requirements for unemployment compensation.

The change involves shifting out of the employed category two relatively small groups of persons formerly classified as "employed—with a job but not at work," as follows:

1. Persons on temporary layoff with definite instructions to return to work within 30 days of layoff are shifted from the employed to the unemployed category;
2. Persons waiting to start new wage and salary jobs within 30 days (except those currently attending school as a major activity) are shifted from the employed to the unemployed, and those attending school are shifted to the "not in the labor force" category.

Employment and unemployment figures were made available on the new basis beginning with the publication of February labor force figures, and revised figures for January were issued at the same time. The change in definitions increased the number shown as unemployed by about 300,000 for January and 250,000 for February. On the basis of figures for 1955 and 1956 it is anticipated that the new basis will shift an average of about 250,000 persons a month from the employed to the unemployed category. During all of 1957 figures for major categories will be made available on the old basis as well as the new, in order to facilitate valid comparisons.

In its press release of February 25 announcing the change in definitions, the Bureau of the Census stated:

". . . Under the old definitions, the reason for classifying these '30 day' groups as 'employed,' though not actually at work, was that they had definite jobs reserved and were not problem cases for whom jobs should be found or created. On that basis, it was regarded as preferable to separate them from what were considered the really unemployed, who had no such definite association with a job.

"In recent years, however, there has been a growing tendency for closer long-term attachment of workers to particular employers, both because of the interest of the worker in the privileges and rights, including pension rights, provided on the basis of seniority, and of the employer in a stable work force familiar with his lines of work. In times of decline in business activity this attachment is preserved by the employer 'laying off' workers rather than severing connections completely, and by the worker refraining from seeking other jobs during the layoff period. It is still true, for these workers that are laid off but maintain a definite tie with some employer, that they are not problem cases in the same sense as people without job attachments. It now is more logical, however, to recognize that they do no actual work and receive no pay for weeks at a time, and that from the point of view of evaluating the state of the economy, they are properly classified as unemployed."

These modifications in definition were made only after careful consideration by a wide group of labor market analysts. In 1954 a Review of Concepts Subcommittee of the Interagency Committee on Labor Supply, Employment and Unemployment Statistics was appointed by the Budget Bureau to "make an intensive exploration and review of the concepts of the labor force, employment, and unemployment used in population surveys, establishment reporting, and administrative records." This subcommittee included labor force technicians representing a wide number of Federal agencies interested in employment and unemployment statistics either as producers or as users of the statistics: Charles Stewart (chairman), Bureau of Labor Statistics; Gertrude Bancroft, Census Bureau; V. D. Chavrid, Bureau of Employment Security; Louis Ducoff, Agricultural Marketing Service; Margaret Martin, Budget Bureau; Gladys Palmer (ex officio, as chairman of the Interagency Committee); George Shultz (succeeding Clarence Long and Al Rees), Council of Economic Advisers; Paul Stanchfield (secretary), Bureau of Labor Statistics; Emmett Welch, Office of Defense Mobilization; and Murray Wernick, Federal Reserve.

The subcommittee held hearings and solicited and received comments and proposals from a wide range of business, labor, government, and university and research groups. Its Interim Report was published in the Hearings on Employment and Unemployment Statistics before the Subcommittee on Economic Statistics of the Joint Economic Committee, held November 7 and 8, 1955. The Interim Report was considered by the Interagency Committee on Labor Supply, Employment and Unemployment Statistics and, following acceptance, was transmitted to Raymond T. Bowman, Assistant Director for Statistical Standards, Bureau of the Budget, for action. To ensure that there was official support for the approval already given by the technicians, Mr. Bowman referred the report for comment to the heads of the agencies represented on the subcommittee. No objections were raised to proposals affecting the Current Population Survey.

The subcommittee's recommendations for the changes in definition were reviewed by Mr. Bowman with the Policy Committee on the Current Population Survey, which advises the Office of Statistical Standards, Bureau

of the Budget, on policy issues of interdepartmental concern affecting the Survey. Members of the committee are Mr. Bowman (chairman), Robert W. Burgess for the Department of Commerce, Ewan Clague for the Department of Labor, and Oris V. Wells for the Department of Agriculture. With the advice and approval of this group, Mr. Bowman transmitted to the Census Bureau the formal recommendation of the Bureau of the Budget that the proposed changes be adopted.

—Margaret E. Martin,
Office of Statistical Standards,
Bureau of the Budget

Special Census Program of the Bureau of the Census

In the period April 1, 1950 to December 31, 1956, the Bureau of the Census conducted some 760 special censuses at the request and expense of local governments. In the whole decade 1940 to 1950, the corresponding number was only about 400. In general, the areas for which special censuses are taken are those which have experienced unusual increases in population because of changes in boundaries or as a result of relatively high in-migration.

During April 1957, special censuses covering an estimated population in excess of 12 million are being taken in New York State. Among the areas covered by this program are New York City, Suffolk, Rockland, Westchester, St. Lawrence, and Onondaga counties, as well as most of Nassau and Niagara counties. In addition, the population of 110 towns, cities, and villages in other counties of the State is being enumerated. The special census activity in New York State grows out of recent legislative action which authorized local governmental units to contract with the Bureau of the Census for special censuses to be taken as of April 1 and to be certified by October 1. The certified population will serve as the basis for the computation of State assistance in subsequent fiscal years until the next Decennial Census.

Most special censuses are taken to enable the local community to qualify for additional revenue. A number of other States also recognize the results of special censuses in the distribution of State funds to localities on a per capita basis. Areas experiencing rapid growth find that the additional revenues more than offset the costs of the census; some communities find it profitable to conduct more than one special census during an intercensal period. Several cities have had as many as five special censuses since April 1, 1950.

Population levels are also important in the determination of the operations of other State laws. The form of government of an incorporated place, the salaries of local officials, or the number of liquor licenses, for example, may be linked to the population of the area. Other uses of current population figures collected through special censuses are for purposes of planning or of civic pride, including the attainment of metropolitan status.

In many instances in which the primary reason for the census is the establishment of a population basis for obtaining revenue, other purposes are served by the special census. School officials may be interested in the number of children in the pre-school ages by location within the city, civil defense officials in the distribution of the current population, and planners in population shifts since the decennial census. The tabulations of the results of the special census can meet these needs.

The minimum amount of information obtained for persons in a special census consists of name, address, race, age, sex, and relationship to head of household. The local communities may obtain additional information, such as income, school attendance, or mobility status. Such additional detail, of course, increases the cost of the special census.

In the New York State program, with the concurrence of local officials, special procedures are being employed in the city of Yonkers and a small portion of Manhattan. These procedures are designed to provide a supply of forms, filled in by enumerators and respondents, suitable for testing an improved model of FOSDIC (the Film Optical Sensing Device for Input to Computers which, by reading microfilms of position-marked schedules, creates impulses on magnetic tape and thereby eliminates the manual punching process). Variations of enumeration techniques, possibly applicable to special censuses or to the coming Decennial Census, are also being tried in Yonkers. These include tests of the feasibility of obtaining information in advance with verification on the census date, of shortening the period during which all persons are first entered on the schedules, of the use of self-enumeration, and of recording information for visitors staying in the dwelling unit on the night of March 31-April 1. Visitors would be enumerated even if they claimed a usual place of residence elsewhere. These tests have been planned because of the possible contribution of these procedures to improved coverage.

The results of the special censuses are published in the Series P-28 reports. Copies of the P-28 reports may be obtained on request from Mrs. Halcyon K. Bauman, Population Division, Bureau of the Census, Washington 25, D. C.

—Henry D. Sheldon,
Population Division,
Bureau of the Census,
Department of Commerce

Review of Present Systems of National Accounts

The Office of Statistical Standards, Bureau of the Budget, has contracted with the National Bureau of Economic Research to review our present systems of national accounts and formulate recommendations for their continued development and improvement. As a pioneer research organization in the systematic development of national income estimates, the National

Bureau of Economic Research is in an excellent position to review the present status of the work and to advise on the formulation of long-range development goals.

The National Bureau has established a National Accounts Review Committee, under the chairmanship of Raymond W. Goldsmith, to survey the Federal Government's national income work, the flow of funds work, and inter-industry relations studies. Other members of the committee are also well known specialists in the field: V. Lewis Bassie, University of Illinois; Gerhard Colm, National Planning Association; Edwin B. George, Dun & Bradstreet; Joseph C. Pechman, Committee for Economic Development; Roy L. Reierson, Bankers Trust Company; Richard Ruggles, Yale University; Lazare Teper, International Ladies Garment Workers' Union; and Richard Easterlin, University of Pennsylvania and National Bureau of Economic Research, who serves as committee secretary.

The committee has met with various groups of users, with Federal agencies producing component series or data incorporated into the national accounts, and with various academic specialists. It has also consulted with representatives of the United Nations and the Organization for European Economic Cooperation and with various European scholars to survey some of the advances made in other countries. It has established a number of subcommittees to prepare preliminary statements on major aspects of the individual systems of accounts and their interrelations, such as: short term estimates; welfare, valuation, imputation; national balance sheet, capital accounts; government; sectoring in personal sphere (by size, social class); regional estimates; input-output; moneyflows; accuracy specification and adequacy of data presently used; rest-of-world account; financial intermediaries; productivity and deflation; unincorporated business, etc.

During the course of the next few months the committee will review more directly with the specialists in the Government the problems in producing data used in the various national accounting systems and the considerations involved in various alternatives suggested by users, and will prepare its own report to the National Bureau. The National Bureau's report to the Budget Bureau will be made by June 30, 1957. It is hoped that the findings of this report will help crystallize the longer range plans of the agencies responsible for work in the various field of national accounts, will evaluate and balance them in the perspective of the needs and problems seen by those who utilize the data for policy and analytic purposes, and will help chart a course for further advances in this work comparable to those made in the past years by the agencies involved.

—Stanley Lebergott, Office of Statistical Standards, Bureau of the Budget

Passenger Travel Survey by the Census Bureau

A national travel survey is being undertaken by the Bureau of the Census to obtain statistics on passenger travel patterns for 1957, and to serve as a pilot study for the travel phase of the proposed 1958 Census of Transportation. The survey is being sponsored primarily by the National Association of Travel Organizations.

Information will be collected from about 2,000 households each month, the households being one-half of the outgoing panel in the Current Population Survey. Field collection started in February to obtain information on trips that ended between January 1 and mid-February. Similar inquiries will be made each succeeding month, in order to obtain calendar-year statistics and to measure the seasonality of selected aspects—with respect to variations among the days of a week and also among longer periods, such as quarters of the year or "travel seasons."

A pretest of the survey procedures was completed in December in the St. Louis and Los Angeles metropolitan areas. Those tests indicated that persons in about one in five households take a trip in any given month, and that an average of two persons in the household go. On the basis of these results, it is tentatively estimated that the gross sample of 2,000 households will lead to about 400 households in which about 800 persons take trips of some sort each month.

For purposes of this survey, a trip is defined as any travel that involves being out-of-town overnight, or going to a place that is over 100 miles away and returning the same day. In general, a responsible person in each of the sample households will be asked if anyone in the household took a trip since the beginning of the preceding month. If one or more trips were taken, the following information will be obtained for each trip: (1) the day and date trip started and ended; (2) destination; (3) means of transport used; (4) persons in household who took the trip; (5) reason for going; and (6) family income by six broad income groups. Records already available from the Current Population Survey will be used to supply additional information about the travelers (age, sex, etc.), the household, and its location.

Tabulations will show the number of persons and elapsed-days on trips, classified by various significant factors such as income level, means of transport, purpose of trip, age, geographic location, and distance. The distance from home to destination will be obtained by coding the origin and destination cities in terms of an arithmetic grid and using mechanical tabulating equipment to compute straight-line miles between the two points.

—Donald E. Church, Chief, Transportation Division, Bureau of the Census, Department of Commerce

Recent Publications

Health and Demography, chart book issued by National Office of Vital Statistics, Public Health Service, presenting demographic facts with significant implications for public health programs. The material is presented in five sections, each preceded by a short summary; dynamics of population trends in the United

States; population trends for major geographic areas and States; population characteristics—age and marital status; population characteristics—economic; and indicators of health and disease. The charts are reprinted from publications of the Bureau of the Census and the Public Health Service. A Postscript by Dr. Halbert L. Dunn, Chief of the National Office of Vital Statistics, presents a brief interpretation of the meaning of the demographic changes shown in the charts. Available from Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 50 cents a copy.

Our Manpower Future—1955-65, chart book issued by the Department of Labor in connection with its Skills of the Work Force Program. The charts depict anticipated changes in population and labor force by 1965, and illustrate some of the implications for the educational system, industrial training programs, and plans for manpower utilization. Available from Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 30 cents a copy.

"The Role of U. S. Investments in the Latin American Economy," reprint of article in the January 1957 issue of the *Survey of Current Business,* issued by the Office of Business Economics, Department of Commerce. The article presents preliminary tabulations from a special survey last year of the direct investment operations of U. S. companies in Latin America in 1955. The objective of the survey was to obtain data on U. S. foreign investments which are not collected in the standard balance of payments reports, but which are essential for understanding the full effects and significance of the operations of these companies on the economies of foreign countries and the United States. New data developed by the survey include total sales of the U. S. enterprises, including production for export and local consumption; imports of capital equipment and materials; remittances of income and fees; local payments for materials, wages, taxes, etc.; numbers of local and U. S. employees; gross investments for plant and equipment, inventory accumulation, and development and exploration of new resources; and the sources of funds used by the companies. The article gives these data for many countries and major industries in Latin America. Reprint available without charge from Balance of Payments Division, Office of Business Economics, Department of Commerce, Washington 25, D. C.

"The Growth in Protection Against Income Loss from Short-Term Sickness: 1948-55," reprint of article in the January 1957 issue of the *Social Security Bulletin,* issued by the Social Security Administration. The article presents, for calendar years 1948 through 1955, annual estimates of income loss due to the short-term sickness of wage and salary workers and the self-employed, and estimates of the amount of protection against such losses through insurance and the value of sick-leave paid. Reprint available without charge from the Division of Program Research, Social Security Administration, Washington 25, D. C.

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RESERVE SEPTEMBER 10-13 FOR THE 1957 A.S.A. ANNUAL MEETINGS IN ATLANTIC CITY, NEW JERSEY

ORGANIZATIONAL PROBLEMS RELATED TO LARGE SCALE STATISTICAL COMPUTATIONS AT BUREAU OF CENSUS*

JOSEPH F. DALY
Bureau of the Census

Let us make it plain at the outset that we at the Bureau of the Census do not claim to know how best to use automatic computing equipment for large scale statistical data-processing. However, we have been using electronic computers—some 40,000 hours of operating computer time in the last five years—on this sort of work. During the course of these years we have encountered difficulties. Some of these difficulties came from malfunction of equipment. These I do not propose to dwell on here. They have not constituted anything like the major share of our troubles; and I think it safe to say that electronic computing systems can now be counted on to run at least as reliably as aircraft engines.

The difficulties that I would like to concentrate on are those related to the planning and organization of statistical data-processing jobs. Some of our difficulties may be peculiar to the specific jobs we do. But some of them, I am convinced, are inherent in statistical data-processing, and must be taken into account by anyone who is rash enough to accept such a data-processing job at his computing center.

In an effort to point up these difficulties, let me outline briefly the problem of processing our monthly Current Population Survey. This is a fairly large sample survey from which we make estimates of the number of employed persons in the United States, the number of unemployed persons, and a host of other characteristics of our changing labor force and demographic situation. This is really a rather attractive computer job. In the first place, there is a premium on getting the results out quickly. In the second place, it is not merely a matter of sorting the filled-out questionnaires into a few piles and counting them. The weight to be assigned to an individual's report varies from one report to another, depending upon where the person lives and upon how many other persons in the same age-sex group were found in the sample, as well as upon other conditions which we need not consider in detail for our present purpose. This particular sample estimation technique enables us to get more for our money out of the field work, but it poses a neat computing problem especially to the person who wishes to estimate the sampling variances of the survey results.

* Revision of remarks at the annual meeting of the American Statistical Association in Detroit on September 10, 1956.

But this estimation problem requires for its solution nothing more complicated than mathematics and theoretical statistics; moreover, once it has been solved, the problem stays solved. The real problem of processing data at high speed on an automatic computer comes from the data and from the purpose which the data are intended to serve. In order to simplify the discussion let us confine our attention for the moment to the estimate of the number of unemployed persons. Let us suppose that you have three or four dozen boxes of punched cards, each bearing punches in four columns for residence identification, two columns for age, and one column for sex, as well as one column for employment status. Let us suppose further that these punches reflect faithfully what was reported on the questionnaires. You have written and tested a computer program which tells the computer exactly what weight to assign to a report for each of the twelve hundred permissible residence codes, and how to modify this weight in accordance with the age-sex group into which the report falls. The computer is further instructed to add this weight into memory position 600 if the punch in the employment status column is a 3, and to print out the resulting total at the appropriate time. You arrange to have the program and the data fed into the computer and prepare to relax while science takes over and performs its miracle of whirlwind computation.

But what happens? In this case what would probably happen is that in about 1.03 seconds the computer would either start to type out something resembling last year's Defense Department budget, or write madly on the program tape, or simply stall. If this is your first data-processing job, you then call for the duty engineer. You point out gently to him that if he would be as careful in checking his machine as you have been in checking your program, you would be able to get on with a job that a lot of important people are waiting for. The engineer ponders for a moment, decides that he might just as well not say what he has usually been saying on such occasions, and busies himself in performing some weird tribal rites on the computer console. These maneuvers appear to convince him, at least, that the computer is in good shape. He starts your program up again, steps through it at low speed, and eventually demonstrates to your chagrin that

the trouble arises because one of the records has a residence code which is not among the twelve hundred that you have provided for in your program, or that the record has a ten's digit of age that looks to the computer as though it is less than zero, because it is blank. Since the records, by our assumption, reflect accurately what was recorded on the questionnaires, obviously some interviewer has made an error, either by failing to record something because he is being pursued at the moment by an unfriendly dog or a pack of playful children armed with tommy-guns, or by inadvertently writing the office telephone number in place of the area code.

You have now had your first lesson in statistical data-processing. You consider calling the chief of the Field Division and asking him if he has run out of trained enumerators. But you recall that he has recently indicated that there were some areas, such as Choteau, Montana, where he was having exactly this difficulty. It occurs to you on further thought that he might be able to have you transferred to Choteau to do the interviewing next month. So on second thought you decide to write an auxiliary program—an editing run—designed to separate the records into two groups, those that meet the specifications with regard to residence codes, age data, etc., and those that do not. Several days after the deadline for the completion of the job you get the new program proved in. You print out the rejected records, process the good ones, and bring the results to the chief of the Labor Force Statistics Unit along with clear evidence that the delay was all his fault for giving you bad data which you fortunately were ingenious enough to screen out before making the final tabulation.

It is highly probable that he will not proceed to congratulate you on your accomplishment. He is more likely to take the attitude that under the old processing procedures, such errors did not seriously affect the operation since most of them were readily detected and corrected in the course of the tabulating operations by a little common sense and knowledge of the subject matter involved. He would therefore show some reluctance to throw away so many perfectly salvageable records (costing two dollars each to collect) just because your giant electronic brain has such a delicate appetite that it cannot digest a little hash along with its normal ration of data. So you turn the reject listing over to some labor force survey specialists, and while they make the corrections that seem so obvious to them, you work on a third computer program to restore the corrected records to their proper places in the file of acceptable reports, and run the tabulation again.

If you are lucky, that is, if no errors escaped or were introduced by the correction operation, you finally complete the job, having used a hundred computer hours instead of thirty, and ten calendar days instead of two.

At this point you might well conclude that automatic computers are fine for simple jobs like handling two hundred simultaneous linear equations or for solving a system of partial differential equations with assigned boundary conditions, but that they are just not designed to cope with real live data, containing the inevitable smattering of contradictions and half-truths found in real life. You might hold this opinion even more strongly if you had been faced with the actual Current Population Survey questionnaires instead of with the simplified version we have been discussing. For in actual practice our interviewers do not determine a person's employment status by saying to him: "Are you unemployed? Answer 'yes' or 'no'." The interviewer actually begins with the question: "What were you doing most of last week—working, or something else?" The answer to this question is recorded in one of seven categories. He then proceeds to go through seven or eight other questions, some of which he may skip depending on the pattern of response to the previous questions. If we allow for possible malfunction of the recording process from the questionnaires to the tabulating medium, we find that there are more than a million million million different patterns which must be classified into one of seven employment status categories. Only a few thousand of these have any perceptible probability of occurring, assuming that reasonable care is taken in recording and preparing the data for tabulation. But it is obvious that making it clear to the customer that he must provide perfect data to the computer or all bets are off is no solution to the problem. The only thing that will make it reasonably probable that the computer will run through the job automatically and come out with a useful result is to program the machine in such a way that it will do something acceptable with any possible pattern of information with which it will be confronted.

Now this state of affairs need not necessarily lead us to the conclusion that high-speed automatic processing of statistical data is impossible. In fact, it is just this state of affairs that makes the modern computer such a powerful tool in statistical data-processing. Present-day electronic computers are large enough and fast enough so that they can apply to the data all the rules that a group of clerks could be instructed to apply in detecting and reconciling inconsistencies and inferring missing information. Moreover, the computer does not get bored by this type of work.

The machine can also be made to examine the final results for consistency with other available information. This is not a trivial matter in statistical data-processing. In our survey of employment and unemployment, for example, the object of the game is not to collect data which will keep the computing machines busy and happy, but to find out as well as we can within the limits of our resources just how the national employment picture is changing from month to month. And if this month's figures are too far out of line with last month's, we are going

to have to find out why this is so before anyone can use the figures intelligently.

Against this background we can now take a look at possible ways of organizing a computer group to process statistical data. From the point of view of the persons most closely associated with the performance of the machines themselves there is perhaps an ideal way to do this. The charter of the group might read somewhat as follows:

1. All computer programs must be prepared by members of the computer staff.
2. No programming will be initiated until complete and unambiguous specifications have been received from the sponsor of the job; such specifications must in addition meet with the approval of the computer staff from the point of view of efficient utilization of equipment.
3. The scheduling and performance of the work shall be under the complete control of the computer staff, and no work will be started until there is a sufficient backlog of data ready for processing to ensure orderly operation.
4. If after a job has been started the sponsor wishes to change the specifications, the sponsor shall be charged for all work done to date and the computing staff shall have the right to require that the job be renegotiated from the beginning as a new job.
5. The computer group shall not be expected to find paying work for the computer at times during which no jobs meeting requirements 1 through 4 above are available.

This is not the system currently in use at the Bureau of the Census, where we have literally thousands of different data processing jobs to do during the course of a year, and where we keep two computers busy around the clock, seven days a week. Our actual charter for the computer group might be caricatured as follows:

1. The computer group is responsible for supplying at any and all times a computer and auxiliary equipment in operating condition, together with competent operators at the console.
2. The group stands ready to provide training in computer programming and a limited amount of other assistance to any customer who has money to spend on buying computer time provided only that the Bureau has the time and the legal authority to take on such work.
3. The customer is responsible for carrying out all phases of the job other than the actual pressing of buttons on the console of the computer.

This is of course a rather extreme way of describing our treatment of the computer section. But I will admit that there is some justification for referring to it as the "Laundromat," where the customer is encouraged to feel free to bring in his money and whatever laundry he considers to be in need of processing through the machine. The management does, however, retain the right to insist that tire-chains and packages of bubble gum be removed from trouser pockets before anything is allowed to go into the equipment.

It would probably be more accurate to say that instead of having a computing center at the Bureau, the entire Bureau is the computing center. Since we have so many different, non-recurring jobs, we are inclined to feel that it is easier to teach statisticians of all types, from labor force experts to experts in the statistics of foreign trade, how to tell the machine what they want it to do than it is to try to train computer specialists in the fine points of all these various subject matter fields. Admittedly this approach does not produce the most elegant computer programs for short jobs. It also has the disadvantage that our subject-matter experts have been known to overestimate their skill in programming and to try to do too many ingenious things to their data, things they would not have dared to try if they had to explain them to someone else or to do them on conventional tabulating equipment. On the other hand, those jobs which are done many times such as the basic part of the Current Population Survey, or jobs which are expected to take many hundreds of computer hours like the first run in the Census of Population, can be given a high degree of polish by a relatively small staff of programming specialists.

I am not campaigning for any particular type of organization. My primary purpose is to point out what problems must be faced before we can use high speed automatic computers to best advantage in processing statistical data. There is, I believe, a difference between mathematical computation and statistical computation.

(Continued on page 23)

RESERVE SEPTEMBER 10-13 FOR THE 1957 A.S.A. ANNUAL MEETINGS IN ATLANTIC CITY, NEW JERSEY

BASIC INSTRUCTIONS IN STATISTICAL COMPUTATIONS*

PAUL S. DWYER
University of Michigan

I wish not only to describe the past and present basic instruction in statistical computation at the University of Michigan, but also to discuss certain topics which should be considered in formulating a program in basic instruction in statistical computation and to make several suggestions for such a program. More precisely I wish to discuss such topics as

The varied instructional programs of a large university
Training in the various programs at Michigan
Computational equipment at Michigan
The nature of statistical computations
The use of digital machines
The control of computational error
The use of direct or iterative methods
The accumulation of inherent error
General remarks with reference to a suitable program of basic instruction in statistical computations

The Varied Instructional Programs of a Large University

It should first be indicated that basic instruction in statistical computation should vary with the different instructional programs. At Michigan, for example, there are several different groups studying statistics so the instructional program should vary according to the objectives and needs of the students in these groups. These groups may be quite diverse. There can be, therefore, no one basic program of instruction in statistical computation. Among the groups studying statistics and allied topics we might mention six for which the instructional program in statistical computation might vary. These groups are:

A. A group of doctorate students who are interested in the mathematical or theoretical aspects of statistics and probability who are not as students, and presumably never will be as professionals, especially interested in computational work.

B. A group of doctorate students in statistics who are very much interested in improved computational techniques which are to be used in solving statistical problems with special interest, perhaps, in the solution of those statistical problems arising in some particular fields of application such as business administration or psychology.

C. A group of students looking forward to a master's degree in statistics. Almost without exception the members of this group expect to get statistical jobs and are interested in learning about statistical computations as well as statistical theory.

D. A group of students taking one or two introductory courses in mathematical statistics. These students also are usually interested in learning the computational techniques appropriate to the statistical concepts they are studying.

E. Groups of students at both undergraduate and graduate levels who are interested in statistics primarily because of the relation to their field of concentration. These groups are especially interested in those computations appropriate to the statistical techniques commonly used in their respective fields.

F. Many statistical problems can be reduced to mathematical problems such as the treatment of linear systems of equations, the determination of the inverse matrix, and the resolution of eigenvalue problems. In addition to the five classifications of students studying statistics there are additional students both in mathematics and in applied fields who are interested in practical solutions of these same fundamental problems.

It is obvious that different basic instruction in computation is appropriate to these different groups. At Michigan, our courses and our computational training programs are designed with these different types of students in mind.

Training in the Various Programs at Michigan

In general the needs of these six classes of students are met at Michigan by the following four types of courses.

1) The courses in mathematical statistics at the 100 level (open to upper classmen and containing the basic courses in statistics required for the master's degree) emphasize training in computation as well as the theory and mathematics of statistics. The classes are held in rooms equipped with desk calculators which are frequently used in class, which are used in the preparation of class assignments, and which are used in tests and examinations. These

* Adapted from a paper presented at the Detroit meetings of the American Statistical Association September 9, 1956, as a part of the Symposium on "Training in Computational Methods—1: The Training and Research Program Adopted at Certain Universities."

remarks are generally true not only for the introductory courses in mathematical statistics, but also for such intermediate courses as analysis of variance and multivariate analysis. These courses serve the needs of those in groups B, C, and D.

2) The courses at the 200 level in probability and mathematical statistics, open to students with a background in pure mathematics as well as to those who have completed the statistics courses at the 100 level and the prerequisite courses in mathematics, make a theoretical and mathematical presentation without emphasizing computational methods. In this manner the needs of those in Group A are reasonably satisfied.

3) There are many courses at Michigan in statistics or statistical methods which are designed for the groups described under E. Indeed whole programs of such courses are given by the School of Public Health and by the School of Business Administration while such departments as psychology, sociology and economics give one or more courses in statistics as applied to the respective field. Several courses, which emphasize statistical concepts, statistical inference, and computational methods rather than mathematical theory or derivations, are offered by the department of mathematics as service courses for other departments or schools.

In all of these courses in the department of mathematics and elsewhere the basic instruction in statistical computation is given as an integral part of the courses in statistics. There is no uniform basic instructional program in statistical computations. We feel that our present program, with the instruction in computation designed to fit the needs of the student, is preferable for the varied instructional demands at Michigan.

There are now no special courses offered which concern themselves with statistical computation as such though during the late 1940's there was a course given by the department of mathematics dealing with the development of mathematical theory for, and use of, punched card machines in statistical work.

During recent years the needs of Group F, as well as those of Groups B, C, D, have been met by courses at the 100 level in computational methods. These courses are not designed primarily for statisticians but our students have found them very stimulating. These courses have undertaken a study of basic problems of numerical analysis and give training in suitable methods with modern digital computers. In the past these courses have used MIDAC (Michigan Digital Automatic Computer) located at the Willow Run Research Laboratories. With the location of the more available IBM Type 650 in the Statistical Research Laboratory in the spring of 1956, the emphasis in these courses has shifted to the use of this machine. Since the introduction of this machine, several special short courses in programming and coding for it have been given for the benefit of University personnel who wish to use the machine for research.

In concluding my discussion of this topic, I should perhaps mention the fact that the University of Michigan gives a special two weeks program in digital computation every summer.

Computational Equipment at Michigan

Michigan has featured a strong emphasis on basic computational work in its statistics and actuarial courses since the early 1920's. This is illustrated by the fact that, in the early 1920's, two laboratories, which are also used as class rooms, were equipped with hand calculators so that every student had a machine to use in class and during the examinations as well as in the completion of his home assignments. We feel that the scheduling of classes of statistics which feature computational methods in rooms so equipped, particularly in introductory courses, is essential for integrating the computational aspects of the course with general theory.

About ten years ago, the hand machines in these rooms were replaced by semi-automatic machines. At this time an additional room equipped with semi-automatic machines was made available to students for use during the day when the laboratories were used for classes. Also at this time, provision was made for a room equipped with about a dozen fully automatic machines (of the various makes). These machines are made available, without laboratory fee, to students in intermediate or advanced courses featuring extensive calculations.

Also about this time, additional rooms, in various parts of the campus, were equipped with machines, for the most part semi-automatic, so that the statistical courses given by various schools and departments (an essential part of the program at Michigan) might also use machines in class instruction. At the present time there are classrooms so equipped in the School of Public Health, in the School of Business Administration, and a similar room is shared by the psychology and sociology departments.

Also about ten years ago, an installation of fully automatic hand machines was established at the Statistical Research Laboratory which is under the jurisdiction of the Graduate School. These machines are used, for the most part, by graduate students or faculty members writing theses or doing other unsponsored research who do not have access to such machines in their departments. An assistant is available for individual instruction as to suitable computational methods so the needs of the students classified under Group E are also met in this way.

The simpler punched card machines such as punch, verifier, sorter, tabulator, and a computing machine (IBM 602A) have also been made available to students and faculty doing unsponsored research, at the Statistical

Research Laboratory, though the 602A was discontinued with the arrival of the IBM Type 650. Aside from the one course mentioned earlier which has not been given for some years there has been no formal training program in the use of these simpler punched card machines. Many of the classes in statistics on campus integrate a discussion of the uses of these machines and a visit to the Laboratory as a regular part of the course work. But the student really learns about these machines as he performs his own research. An assistant is available at the Laboratory to assist the student in learning the operation of these machines and to schedule the use of the machines by students and faculty.

During the past three years the University facilities have also included the partial use of MIDAC but this machine, located at the Willow Run Research Laboratories, is owned by the Air Force. With the arrival of the Type 650, which is more accessible and may be used for sponsored as well as unsponsored research, the emphasis in the instructional and research programs is on this machine. In the few months which we have had it, the demands of the University for its use have become so extensive that we are even now forced to give serious consideration to the question of obtaining a larger machine.

I hope these remarks give you an idea of the nature of our digital equipment and the extent to which its use is being integrated into our instructional and research programs. Some remarks about the nature of statistical computations and the proper use of digital machines follow.

The Nature of Statistical Computations

For the most part statistical computations are mathematical computations and, somewhat more narrowly, arithmetic computations. Generally statistical computations which are to be performed on a digital computer must be reduced to an arithmetic involving decimal or binary digits even if some errors are introduced in this reduction.

There is another operation, not commonly considered as a fundamental operation of arithmetic, which is so important in statistical work that I feel it should be included with the fundamental operations of arithmetic as a fundamental operation of statistics. This is the operation of *selection*. Where selection is applied on a large scale, as it commonly is in statistics, the operation may be described as *sorting*. Where the results of the sorting are to be arranged in some particular order, as in the case of frequency distributions, the operation is described as *ordering*. More generally where the operation of selection is applied so that the data are grouped into classes having certain general properties, the operation may be described as *classification*. These operations are all fundamental in the reduction of statistical data. The term selection, which I use to describe all of them, is a fundamental computation operation of statistics and should be so recognized. When it is so recognized the nature of statistical computations becomes clearer.

During the course of history man has accomplished this operation by forming piles of physical objects having similar properties, by tally sheets, by making piles of marked items (such as coins), more recently by collecting marginal punched cards having identical punches into groups using a needle sort, and with the use of internally punched cards, and sorters. The use of the Hollerith sorter in analyzing the results of the 1890 census was most significant not primarily because some new machine was introduced but because this machine demonstrated a satisfactory mechanization of the basic statistical operation of selection.

For machine use we need to mechanize the fundamental operations. Arithmetic can be mechanized by the application of digiting to digital addition and multiplication tables. By digiting I mean the treatment of the expression of a number as the sum of appropriate integral powers of the base where each power is multiplied by an appropriate digit. Thus

$15 = 1 \cdot 10 + 5 \cdot 10^0$ when the base is 10 and

$15 = 1 \cdot 2^3 + 1 \cdot 2^2 + 1 \cdot 2 + 1 \cdot 2^0$ when the base is 2.

Thus the application of the basic operations to numbers expressed in this digital form (with some qualifications) can be reduced to operations with digits. This is the basic principle of the arithmetic taught in our schools as well as the arithmetic of the automatic computer. In the latter case a binary system is commonly used since the digital addition and multiplication tables are so simple that they need not be considered arithmetic at all.

The next important fact to note is that digiting can be applied to the fundamental operation of sorting when the numbers are, or may be, expressed in digital form. Thus we can order a series of magnitudes by sorting first in the units position, then in the tens position, etc. The punched card sorter then should be considered to be a digital machine just as the desk calculator, the punched card tabulator, and the punched card multiplier are digital machines.

A difficulty with early mechanization of statistical computations was that no machine combined the operation of selection with the fundamental operations of arithmetic, though some partial combinations were achieved. For example, the use of digit selectors on punched card tabulators made possible the efficient calculation of summed products on machines which were basically adding machines. Later the IBM 101 combined features of the sorter and tabulator. But the mechanization of *all* the fundamental operations of statistics had to await the development of the modern digital computers which are designed for selection and ordering as well as for the basic arithmetic operations. In concluding my

remarks on this point I would like to state that basic instruction in statistical computation should emphasize the fundamental nature of the operation of selection and should point out the need for additional digital machines to supplement the desk calculator.

There is one more point on the nature of statistical calculations dealing with more advanced concepts than sorting. This is that, though the statistical operations seem to be identical with mathematical operations which have been programmed, this is not necessarily the case. For example, the physicist or engineer may know from the properties of the model that certain systems of linear equations have non-singular matrices. Then routines, direct or iterative, based on the existence of an inverse are appropriate. This does not necessarily hold when the matrix results, directly or indirectly, from statistical observations since there is no guarantee that the matrix is non-singular. In this case methods should be used which demonstrate that an inverse matrix exists, if it does, and if not a method appropriate to the problem should be used.

The Use of Digital Machines

Digital machines have limitations which are of theoretical, and sometimes of practical, importance. One should always be aware of the mechanical defects, such as inadequate carryover, of the machine he is using. More important he should be aware that the use of digital equipment commonly forces the introduction of error in reducing a number to digital form. Also he should recognize that while the operations of addition, subtraction and multiplication yield digital results, the result of a division operation (or square root operation) is not necessarily digital. This fact must be considered in the control of computational error as indicated below.

Aside from the control of computational error, it is essential that the fundamental operations, particularly with hand machines, be arranged in such order that a minimum of recording and resetting on the machine is required. The general spirit of this, the collection of the fundamental operations into operational units which the operator-machine can handle most efficiently is somewhat similar to the spirit of programming for automatic computers, the determination of specific instructions for combinations of operations which the machine can carry out alone. In this sense the programming of the operations for hand machines should be good training for the programming of the operations for automatic machines.

The Control of Computational Error

One method of controlling the computational error arising from a series of operations involving approximations, such as division or square root, is to avoid the approximate operation or at least to postpone it as long as possible. Thus the conventional formulas for the sums of the square of the deviates of the digital X

$$\sum (X-\overline{X})^2 = \sum X^2 - \overline{X} \sum X$$

is not as satisfactory as

$$\sum (X-\overline{X})^2 = \frac{N \sum X^2 - (\sum X)^2}{N} = \frac{L}{N}$$

where L defines the large variance, since in the first case the rounding error of the recorded mean, $\overline{X}$, may be augmented considerably when it is multiplied by ΣX while in the latter case there is no rounding error in the numerator (to machine capacity) and the value can be computed as a single machine operation once the values of ΣX and ΣX^2 are computed by a preliminary operation In my opinion the somewhat formidable formula

$$t^2 = \frac{(N_2 \sum X_1 - N_1 \sum X_2)^2 \ (N_1+N_2-2)}{(N_2L_1+N_1L_2) \quad (N_1+N_2)}$$

is a much more satisfactory formula, from the standpoint of ease of computation as well as the avoidance of computational error, than that usually given. A single square root, with the sign of t determined by the sign of $N_2\Sigma X_1 - N_1\Sigma X_2$ then determines t. For a two-tailed test the value of t^2 may be referred to an F table with $n_1=1$ and $n_2=N_1+N_2-2$ degrees of freedom so that no square root is necessary. In many experiments, the size of the control group is that of the experimental group so that the computing formula simplifies to the simple relation, with $N_1=N_2=N$

$$t^2 = \frac{(\sum X_1 - \sum X_2)^2 \ (N-1)}{L_1+L_2}.$$

The analysis of the large variance in factorial experiments involving equal numbers of replications results in simple formulas featuring digital numbers up to the determination of the F's. It is my opinion that basic instruction in statistical computations should feature improved computational methods of this sort.

Direct Versus Iterative Methods

One of the questions arising in statistical computation is that of direct versus iterative methods. In general it appears that in the basic work one should emphasize direct methods of solution since these are commonly better understood by the students as solutions of problems. On the other hand, I have come to the conclusion that, to obtain an approximate square root of a number on machines equipped with automatic division, an iterative process which averages the result of a division of the number by a trial root with the value of that trial root is more satisfactory than other methods, which might be called direct.

This question is especially pertinent in connection with the solution of systems of equations arising in least squares regression problems. If the number of variables

is small, the argument for the direct application of the fairly simple formulas for the regression coefficients is very strong. Personally, I prefer the direct solution of the equations to an iterative solution unless, as is commonly not the case in statistical work, the matrix of the equations has some particular property which makes it especially suited to an iterative process. In general, when the non-singularity of the matrix is not necessarily established, it seems essential that we use direct elimination methods. As a matter of fact, the order of the elimination may be frequently chosen so as to avoid the divisions by small numbers which are largely responsible, in many problems, for a considerable portion of computational error. In the more extreme cases in which the rank of the coefficient matrix is appreciably less than its order, one solution of the equations, which is equivalent to the selection of subsets of variables, can be accomplished by direct methods.

On the other hand, in an eigenvalue problem in which the chief principal axis only is desired, some such iterative method as Hotelling's is to be preferred.

The selection of direct or iterative methods should depend then on the nature of the problem to be solved. But the proper use of iterative methods, particularly as applied to a linear system, demands certain information about the coefficient matrix. This information is not always available in least squares regression problems. Direct methods are then indicated.

The Accumulation of Inherent Error

An extensive use of iterative methods, particularly in the study of linear systems with the resultant undetermined computational error has led to an emphasis on the analysis of computational error. In my opinion this emphasis is misplaced. Frequently we can do something about computational error. By using direct methods and/or with the use of a sufficient number of iterations, the solution can frequently be found to the required degree of accuracy. But we cannot remove the accumulated error which results from the measurement errors and the rounding errors of the elements of the computing problem. It seems to be tacitly assumed that these errors are random and should cancel out so that they may be ignored. Unfortunately this is not usually the case, particularly with problems involving determinants, linear systems, and matrices. A slight change in one of the elements of a determinant may make an enormous change in the value of the determinant if the cofactor of that element is very large. Correspondingly, the solution of systems of equations may change considerably with slight changes in the equations. These changes are sometimes of such magnitude that some such rule as the following should be accepted. *Never consider the evaluation of a determinant, the calculation of an inverse matrix, or the solution of linear systems complete when the coefficients are subject to error until an estimate of the accumulation of this error is provided.* Linear bounds for this error, quite satisfactory when the errors of the coefficients are small, can be determined with the use of the approximate inverse or approximate adjoint matrix if bounds for the error of the coefficients are known.

It is my opinion that the emphasis on the untrustworthiness of results of statistical computations which take no consideration of the accumulation of inherent errors should be just as much a part of the basic instruction in statistical computations as is the present emphasis on sampling errors.

General Remarks

In conclusion I would like to make some specific suggestions which supplement suggestions mentioned previously.

1. On the question of uniform desk computers versus a variety of models, it is our experience in the department of mathematics at Michigan that it is preferable to give the basic instruction on uniform machines. However, all the latest computing models of automatic machines should be available and used by those who are engaged in intermediate or advanced work.
2. Computational aids should not be limited to desk computers, even in basic instruction. Tables, slide rules, nomograms, etc., should also be available to supplement the work with the machines.
3. Training for the simpler punched card machines is best accomplished when the student is faced by problems requiring the use of these machines.
4. It does not seem feasible, at least at a university organized as Michigan is, to have a single program of instruction in statistical computations. But the instructors in the various programs should be aware of the nature of the instruction offered in the different programs and of the availability of university equipment so that these programs may be integrated in spirit even if not formally.
5. Finally, all statistical computations should be specially designed with the limitations of the data, as well as the features of the computational equipment, in mind. Thus it may not be wise to use an iterative method with an electronic computer in solving a set of simultaneous equations, even though such a method is appealing to the programmer because of the possibility of using subroutines, if it is uncertain that the matrix of the coefficients is not singular or almost singular. The computational design should attempt to control the computational error and, at least in the more complex problems, should provide for an estimate of the accumulation of the inherent error.

I hope these remarks will help us all to provide better basic instruction in statistical computations.

IMPROVEMENT OF FEDERAL STATISTICS*

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This paper is directed to the efforts being made, and the rationale of methods being used, to improve Federal statistics.

In 1848, in his *Principles of Political Economy*, John Stuart Mill, with all the abandon of true genius, wrote:

> "Happily, there is nothing in the laws of value which remains for the present or any future writer to clear up; the theory of the subject is complete: the only difficulty to be overcome is that of so stating it as to solve by anticipation the chief perplexities which occur in applying it: and to do this, some minuteness of exposition, and considerable demands on the patience of the reader, are unavoidable."

Unhappily, I find myself unwilling to say about the Federal statistical program in 1957 what Mill said about the theory of value in 1848. I prefer to think that this is not because I do not have a sufficiency of genius. I hope instead that it merely reflects a general understanding that the statistical program of the United States, although it is recognized as outstanding, nevertheless is not good enough for the demands which are being made on it. In fact the process of improvement must be a continuing one, the ideal always a little in advance of achievement.

I am going to assume that it is not necessary to argue the growing need for organized economic and social data—that is, for statistics. I think we would all agree that appropriate, accurate and prompt intelligence of a quantitative character concerning the way the economy and its social institutions function is necessary in a free society. We must have quantitative intelligence of this kind—what Wesley Mitchell called "analytical description"—to maintain a high level of economic wellbeing without excessive oscillations or unnecessary inequalities, and to reach wise solutions for the social problems of health, of education, and of family living.

We would all agree too that our economic and social statistics should be more expertly designed if they are to be adequate in meeting present day uses—for indications of present positions and past trends, for anticipation of imminent developments, for research in the social sciences, and as a basic tool in determining Government or private business policy.

Starting from these two premises—that statistics are necessary and that improvements are needed—I should like to comment on four factors which I believe must receive major attention in efforts to strengthen the Federal statistical program:

(1) The need for competent and well trained personnel;

(2) The improvement of quality in the whole range of statistical processes;

(3) The importance of proper presentation or publication of statistical data; and

(4) The need for greater integration of our statistical program.

I shall comment very briefly on the first three of these factors, and in somewhat more detail on the fourth.

The importance of adequately trained personnel—the first factor—cannot be overestimated. Skill and training of an advanced type are necessary for the statistical job that needs to be done, and the statistical agencies must be able to employ and hold competent statisticians. Not enough attention is being given to this problem at the present time, particularly in view of the increasing demand for skilled statisticians in private employment. I hope that the Bureau of the Budget, in cooperation with the agencies, can soon give the problem the special study it needs.

The second factor, concerning quality of the data appropriate for their major uses, requires attention to many elements, such as the training of enumerators, the design of the inquiry, obtaining the cooperation of respondents, the selection of samples, and the speed with which the information becomes available. These problems require and have been receiving considerable attention in the development of the Federal statistical program. Their importance is recognized also at the international level, as I was pleased to note at the meeting of the United Nations Statistical Commission last year.

The United States has been fortunate in the general integrity of the respondents to Government inquiries. Accuracy of information requires much more, however, than the cooperation of respondents. The complexity of the information sought, the differing practices of business concerns, the difficulty of communicating questions and answers all require close attention if the information obtained is to be meaningful. Thus new inquiries must be preceded by pilot studies, and

* Adapted from an address given by Raymond T. Bowman, Assistant Director for Statistical Standards, Bureau of the Budget at the annual dinner meeting of the Washington Chapter of the American Statistical Association on January 28, 1957.

older inquiries must inaugurate quality control procedures.

Illustrative of work along these lines is the recent development of a response analysis program by the Bureau of Labor Statistics for its employment statistics series. By meticulous inquiry of a sample of respondents, information is obtained on how well respondents are following instructions and definitions, how well the definitions fit the record-keeping practices of a majority of establishments, and where improvement in practice or changes in definitions and instructions are needed to reduce response errors and make the series more useful for economic analysis. As another example, the Bureau of the Census has been strengthening its program of quality control over the work of the enumerators for the Current Population Survey, scheduling a regular series of reinterviews by supervisors of a sample of each enumerator's work as well as periodic observation of actual enumerations. The Census Bureau is also engaged in experimental work looking toward methods of identifying, controlling and reducing response errors. Programs such as these are particularly important in efforts to improve the quality of statistical data. Response errors must be carefully distinguished from sampling errors, and in many surveys it is more important to reduce response errors than to reduce sampling errors in order to achieve greater accuracy in the results.

I want to mention one other element important to the quality and usefulness of statistical data—the need for greater speed and increased tabulation detail. Fortunately the new electronic computers are making possible great advances in this area, and the statistical agencies are well advanced in adopting these new processes. These new devices not only permit the tabulation of *more* data, *faster* but also provide the means whereby many routine clerical operations—coding, editing, typing, charting—can be transferred to machines. For example, one recent development in the mechanical field, the machine known as FOSDIC (film-optical-sensing-device-for-input-to-computers) is obviating the need for manual card-punching, thus not only reducing direct costs but also shortening time spent and minimizing opportunities for errors.

The third factor, the proper publication of statistical data, is one of the basic objectives of a good statistical system. It matters little how carefully statistics are prepared unless they are presented in a manner to avoid their misinterpretation and misuse. It goes without saying that all misuses cannot be prevented. But skillful and well considered presentation can go far toward indicating proper uses of the data, their degree of reliability, their relations to other series, and other factors needed by careful and intelligent users for proper interpretation.

A list of standards for the publication of statistical data, issued almost ten years ago by the Bureau of the Budget, describes a number of procedures to be followed in order to reduce the areas of misinterpretation of statistical data. Agency practices in this area are generally good—but there is still room for improvement and need for constant vigilance.

The fourth factor is the need for greater integration of the elements of information about our economy. In a decentralized statistical system like that of the United States the separate statistical series which together compose the whole originate in many different agencies, frequently as a by-product of administrative operations. It is generally recognized that in such a decentralized system there has to be an agency whose job it is to see that insofar as possible these separate and independent pieces can be fitted together into a consistent whole. That, of course, is the job of the Office of Statistical Standards in the Bureau of the Budget, which I have had the honor to head for almost two years.

The remarks which follow attempt to describe very briefly the rationale being followed by the Office of Statistical Standards in its efforts toward greater integration of the Government's statistical activities.

First we recognize that an excellent criterion for determining the needs for economic data is found in the development of national accounts. As Edward F. Denison stated in his comments at the annual meeting of the American Statistical Association last September, the national income accounts "provide consistent and integrated estimates for appraising the performance of the economy and studying its operation." Mr. Denison recognized of course that the national accounts do not provide an integrating criterion for all Federal statistics, or even for all Federal economic statistics. They do have implications for almost all economic statistics, however, including price series and indexes for deflation purposes, employment data for assessing GNP productivity changes, inventory data for measuring capital formation, and a host of others too numerous to mention here.

Use of the national accounting technique as a criterion for organizing basic data must, in our opinion, take into consideration the requirements for the several variant systems of accounts—the national income accounts, national balance sheet accounts, flow of funds accounts, and input-output accounts. At least for the time being, however, our major emphasis has been on the data requirements for the national income accounts. Because of the need for more attention to this criterion, the Bureau of the Budget has recently contracted with the National Bureau of Economic Research for an independent appraisal of the national income and product accounts and other accounts systems, directed primarily at determining specific needs for improvement in the underlying statistical series and at investigating means of bringing about better integration of the several systems. This appraisal is now under way, and a report is expected in the Spring of 1957.

From the same point of view we have taken steps to arrange for speeding up preliminary tabulation, on a sample basis, of certain business indicator information from the income tax returns, to give a firmer current basis to the national income accounts. Similarly we have encouraged the further development of the SEC-FTC quarterly financial report for manufacturing corporations, and we hope the extension of this report to include trade and mining corporations will be made possible by appropriation requests included in the 1958 Budget.

Last year the Office of Statistical Standards completed arrangements for the Board of Governors of the Federal Reserve System to become the "focal agency" in the field of saving statistics, to take the leadership in developing a well-integrated body of saving statistics and providing appropriate publication and interpretation of data on personal savings. This arrangement also recognizes the needs of national accounts as a general criterion of integration, but with some further recognition of the need for more internal consistency for the various purposes served by statistics of personal and aggregate savings. The focal agency principle does not require that all the data needs be met by collection programs of the focal agency. It does place in one agency responsibility for leadership in formulating a program to meet analytic needs. Designation of a focal agency in the field of saving statistics follows a recommendation made in its 1955 report by the Task Force on Savings Statistics, appointed by Federal Reserve at the request of the Joint Economic Committee.

Thus far I have commented primarily on current series particularly designed for economic analysis. The national income accounts, however, also make considerable use of statistics which are by-products of administrative programs. One of the most difficult of the tasks of integration is to develop the procedures and techniques for making full use of such relatively inexpensive and complete sources of data, to meet the needs of economic analysis within the framework of the administrative program. The usefulness of the income tax data in this respect has already been mentioned. The basic records of the Bureau of Old-Age and Survivors Insurance also provide an important source of data, not only for use in estimates of the national income accounts but also in a number of other major statistical programs.

Other criteria than the needs of national accounts are of course necessary to guide integration, as I shall try to indicate by a few examples.

The United States probably has the best body of labor statistics anywhere in the world. This is true not only because of energetic work in this field by the early development of a Bureau of Labor Statistics, but also because of the emphasis on the importance of the labor factor in the economy. Employment gives the most direct measure of economic activity in real rather than in monetary terms. In this field efforts at integrating statistical programs must recognize the advantages of having more than one approach to the problem of measuring the economic activity of human beings.

A detailed body of information on employment, wages and hours in nonagricultural industries has been developed by the Bureau of Labor Statistics, with the cooperation of the Bureau of Employment Security, State agencies, and employers. The information is obtained from establishments on a sample basis, and integrated with the comprehensive statistics available as a by-product from the operations of unemployment compensation agencies. Here we have an integrated body of data providing consistent estimates for States and areas as well as the Nation, and providing needed detail by industry.

But the BLS measures of employment are measures of "number of jobs" held in nonagricultural industries, not of the "number of persons" employed. The need for information on the economic activity of the population is met by the Census Bureau's Current Population Survey, a monthly survey of households in which persons of working age are identified as either employed or looking for work, or as not in the labor force. The BLS measure of number of jobs held, with State and industry detail, is an important measure but it is not and should not be made equivalent to the numbers of persons employed in any current period. These two series—the BLS count of number of jobs and the Census series on numbers employed—serve different purposes, and they should not be expected to show exactly the same movements. We should, however, be able to calibrate and explain the general magnitude of the differences between them at different times of the year. Similarly, the unemployment series of the Bureau of Employment Security, based on eligibility for and receipts of unemployment compensation, will never be identical with the Census Bureau's estimates of the number of persons seeking work but not currently working. Here again there is clear need for both approaches, and for knowledge of the general relationship of the two series.

I have used the term "integration" to mean the achievement of consistency, the avoidance of contradiction, in Government's over-all statistical program. In this sense of the word I think it is obvious that there can be no major advantage to integration of these various employment and unemployment series, since part of their value stems from the discrepancies revealed by different approaches. Here our concern is with improvement of the basic data in the individual series and with adequate explanation of the differences among them, so that they may be used together to greatest advantage for purposes of economic analysis. A policy committee consisting of myself as chairman, Mr. Burgess, Mr. Clague and Mr. Wells provides a basis for coordinating the Current

Population Survey with general needs for data on the economic participation of the population and gives general focus to the work of the Census Bureau in this important area. In addition, representatives of our office, the Census Bureau, the Bureau of Labor Statistics and the Bureau of Employment Security each month prepare a press release, issued jointly by the Secretaries of Commerce and Labor, presenting the latest figures on employment and unemployment from all three sources. Certainly in this area we are practicing an art of coordination, if not a science.

I will not try to discuss all the fields in which efforts are being made to achieve major improvements and greater integration, but I should like to mention briefly several other areas which are particularly significant at the present time.

In the field of construction statistics some improvements have been made since the war, but there is general agreement that great improvements are still needed. Repeated efforts have been made in the President's budgets for recent years to get the funds needed to expand and improve present estimates of construction activity. Congress has not approved these requests, however, and in view of the common demand for improvements, I have arranged this year for further review of the field and expect to come up with recommendations for a new program.

Also in the field of current economic indicators, need has been expressed for better data on inventories, particularly manufacturers' inventories. In this case we are attempting to reorient the general series on manufacturers' sales, inventories and new orders along the lines suggested by the Task Force on Inventory Statistics appointed by the Federal Reserve Board at the request of the Joint Economic Committee, and to do this without sacrificing the current simplicity and promptness of the series. This requires some shift in agency responsibility, but we are hopeful that when finally consummated these efforts will bring forth a much better integrated body of information than would be possible by divided efforts.

In the past few years the Department of Agriculture has instituted a program for the improvement of crop and livestock estimates by means of modern sampling methods. The program is still in the early stages, but the results to date are promising. In a way this activity typifies a new era in statistics. It employs modern techniques to produce better results, but beyond that it is creating a statistical framework within which a whole set of integrated agricultural statistics can be developed.

In the field of social statistics there is need for much greater integration. In this area we do not at present have workable criteria to guide the selection of first tasks, and we urgently need to formulate a set of objectives. The new national health survey will provide a base for attacking many problems in this area, and perhaps suggest new needs for related information. In the next few years the Office of Statistical Standards expects to give more attention to this broad field than it has since the outbreak of World War II.

Finally, no discussion of statistical integration can fail to mention the standard classifications developed to provide a comparable basis for the statistical data collected and compiled by many different agencies. In this area the most important activity at the moment is completion of the revision of the Standard Industrial Classification, undertaken by the Bureau of the Budget with full cooperation of Federal agencies and with the advice and assistance of industry groups, labor organizations and private research organizations. The revision takes into account technological changes, changes in industry organization and procedures, and the growth of new industries. It will be used by all agencies in presenting data beginning with 1958, and should result in improved usefulness of our industrial statistics.

I have tried to stress the importance of an integrated statistical program, while at the same time noting that the term "integration" can not have a single operational connotation. It must take on somewhat varying meanings for different purposes. In essence, however, it refers to a statistical program which, as a whole, provides information which is so interrelated as to serve major analytical purposes. In response to the pressures of immediate need, and in the absence of infinite wisdom and resources, new elements will often have to be added, and old elements continued, without sufficient regard to their integration with other parts of the over-all statistical program. But recognition that the goal of perfection cannot be attained completely should not curb our efforts at improvement—for we've a long way to go.

RESERVE SEPTEMBER 10-13 FOR THE 1957 A.S.A. ANNUAL MEETINGS IN ATLANTIC CITY, NEW JERSEY

QUESTIONS AND ANSWERS

Edited by ERNEST RUBIN
U. S. Department of Commerce and American University

Aspects of Economic Intransitivity

Generally speaking you get what you pay for. This generalization is more applicable in certain areas of economic activity than in others. The question to be discussed is how economic intransitivity [1] may be detected and evaluated by statistical methods.

The field of sports furnishes interesting information regarding economic intransitivity. A congressional committee investigated monopoly features of organized baseball and published statistical data [2] not ordinarily found in the various baseball almanacs. Of particular value for my purpose is a table showing the team salaries in both major leagues for six years between 1929 and 1950. [3]

These data make it possible to compare statistically the final standings [4] of the teams with the team salaries for these years. The Pearsonian correlation cofficient, r, can be computed, using the variates game won, y, and team salaries, x. Instead of r, I thought that the Spearman coefficient of rank correlation $\rho = 1 - \frac{6\sum d^2}{n^3 - n}$ would be more useful for this discussion.[5]

The team salaries were ranked from highest to lowest amount and paired with the corresponding place the team achieved at the end of each year. The rank correlations are shown in Table 1.

Table 1. Correlation Between Team Salaries and Final Standings in the Major Leagues for Selected Years

	(Rank Correlation)	
Year	*American League*	*National League*
1920	.72	.24
1933	.74	.45
1939	.79	.11
1943	.60	.14
1946	.90	.02
1950	.81	.52

Testing the significance [6] of the rank correlation coefficients and using P=.05 as the minimum significance level, the rank correlation coefficients of .72 and higher are significant. The results for the American League, except for 1943, indicate a significant correspondence between team salary and final standing. In the National League there appears to be no significant relation between these variables in any sample year. Taking the results of both leagues we have 5 instances of significance but 7 cases of non-significance between team salary and achievement.

Another example from the field of sports furnishes a case of economic intransitivity. I refer here to the correspondence between track odds and final placements in horse racing. Table 2 gives this information for 9 races at Hialeah on March 2, 1957.[7]

Table 2. Correlation Between Final Odds and Final Placement in 9 Races at Hialeah, March 2, 1957

Number of Horses in Race	*Rank Correlation*
7	.68
9	.29
9	.52
10	.06
10	.65
10	.68
11	.11
11	.48
11	.75

Using the test of significance referred to above, and again, P=.05 as the minimum significance level, only the rank correlation coefficient .75 for an 11 horse race was significant.

The foregoing illustrate economic intransitivity, that is, a general lack of correspondence between the expenditures and the corresponding results achieved. While interesting examples of economic intransitivity are found in sports, this phenomenon exists in other fields and is probably more widespread than we suspect.

[1] Economic transitivity describes a relationship of the following kind. If \$x is greater than \$y, and if these amounts are spent to obtain goods or services of an identical type, then \$x dollars will purchase more than \$y. Symbolically expressed, if \$x>\$y and \$x purchases an amount A while \$y purchases an amount B, then A>B. Economic intransitivity occurs when, given the foregoing hypothesis, the final inequality becomes an equality or is reversed, that is B≤A.

[2] Hearings Before the Subcommittee on the Study of Monopoly Power, Serial No. 1, Part 6, *Organized Baseball* (U.S.G.P.O., Washington, 1952).

[3] Ibid, p. 1610. I do not know why or how the particular years (1929, 1933, 1939, 1943, 1946 and 1950) of this sample were chosen. The present discussion proceeds on the assumption that the sample of six years is sufficiently random for our purpose.

[4] Kahn, Roger and Al Helfer, *The Mutual Baseball Almanac*, (Doubleday, N.Y., 1954) p. 139.

[5] I wish to acknowledge the assistance of my son, Michael H. Rubin, who calculated the coefficients of rank correlation and obtained additional baseball data.

[6] M. G. Kendall, *The Advanced Theory of Statistics* (Vol. I), (C. Griffin & Co., London, 1947), p. 401, gives the following t test: $t = \rho\sqrt{\frac{n-2}{1-\rho^2}}$ where n is the number of paired observations and ρ the rank correlation coefficient.

[7] New York Times, Sports Section, March 3, 1957.

Organizational Problems Related to Large Scale Statistical Computations at Bureau of Census —Continued from page 12

In most mathematical problems, we know a good deal about the data and about the operations to which they must be subjected, and we are anxious to see what the results will be. In statistical data processing, on the other hand, we usually have a lot of information bearing on certain facets of the results, but very little information about the data.

We now have computer systems with large memories, with fast input equipment, and with a logical design which permits them to make decisions on the weight of the evidence in cases of inconsistent data. If we are to process statistical data at electronic speeds, we must find a way to let the computers exercise this ability, instead of stopping and printing out "Impossible code." We have to learn how to make effective use of redundancy in our input data, and to write procedures which will ensure that the computer can do something sensible with each record it processes. This means that we have to bring to the computer not only a knowledge of the strengths and weaknesses of the computer itself but also a knowledge of the meaning of the data being processed. This is really a problem of communication. In my opinion, a computer organization is going to be successful in the field of statistical data processing if and only if it succeeds in dealing with this communication problem with reasonable effectiveness.

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NEWS ABOUT MEMBERS

Lois Anderson is now a Statistical Analyst with the Office, Chief of Ordnance, Department of the Army, Washington, D. C.

S. I. Askovitz has received an additional appointment as Medical Statistician to the Albert Einstein Medical Center, Philadelphia.

Kurt W. Back's position is now Research Associate Professor in the Department of Biostatistics of the School of Public Health, and Research Affiliate of the Institute of Research in Social Science at the University of North Carolina. He is working as co-director of the Study of Choice of Specialties in Medicine, which is supported by a USPHS grant to the American Public Health Association.

Glenn E. Bartsch was separated from the Army on September 17, 1956, and has resumed work on his Sc.D. in Biostatistics at the School of Public Health and Hygiene of the Johns Hopkins University, Baltimore, Maryland.

Harold F. Bright, formerly Deputy Director, Human Resources Research Office, George Washington University, is now employed as Specialist, Operations Research and Synthesis, Circuit Protective Devices Department, General Electric Company, Plainville, Connecticut.

Herman Brotman has transferred from the Division of Program Analysis, Bureau of Old-Age and Survivors Insurance, to a new position as Chief of Research, Special Staff on Aging, Office of the Secretary, Department of Health, Education and Welfare.

Byron W. Brown, Jr., formerly Instructor in Biostatistics at the University of Minnesota, is now Assistant Professor of Biostatistics in the Department of Public Health and Preventive Medicine, School of Medicine, Louisiana State University. (Correction of item appearing in February "News About Members.")

Herbert S. Conrad, Director of the Research and Statistical Services Branch, has been named Acting Assistant Commissioner for Research, Office of Education.

Paul R. Dunlap has left the Engineering Division of Glenn L. Martin Co. to accept a position as a Senior Reliability Analyst at RAD AVCO in Lawrence, Mass.

Fred Ederer has transferred from the Bureau of Labor Statistics to join the staff of the Biometry Branch, National Cancer Institute at Bethesda, Maryland. He was previously with the Biometrics Division, Surgeon General, U.S.A.F.

Lillian R. Freedman, formerly Chief of the Health Statistics Section, Division of Research, Children's Bureau, has transferred to the Division of General Health Services, in the U. S. Public Health Service.

Hyman Goldstein is now Chief of the Biometrics Branch, National Institute of Neurological Diseases and Blindness, U. S. Public Health Service. He was formerly Chief, Current Reports Section, Biometrics Branch, National Institute of Mental Health.

Mordecai H. Gordon has been appointed Assistant Director of the Veterans Administration Neuropsychiatric Central Research Unit, located at the V.A. Hospital in Perry Point, Maryland. This unit is currently predominantly engaged in serving as the coordinating and advising point for a 41-hospital cooperative investigation of the differential effects of certain tranquilizing drugs.

H. O. Hartley represented the Iowa State College Statistical Laboratory at the Fourth Annual High-Speed Computer Conference, held at Baton Rouge, Louisiana, March 5-8, 1957. On March 6th Professor Hartley presented a paper entitled: "Some Programming Problems Arising in Agricultural Research."

G. Ronald Herd received a Ph.D. degree in statistics from the Department of Statistics, Iowa State College, in December 1956; his doctoral thesis dealt with "Estimation of the parameters of a population from a multi-censored sample." He is remaining with Aeronautical Radio, Inc., in Washington, D. C., as consultant in the Reliability Research Department.

William T. Hirnyck has accepted a position as Quality Control Supervisor at the Wilmington, Delaware plant of the Continental Can Company, Inc., Bond Crown & Cork Division.

Paul G. Homeyer spoke before the Agricultural Experiment Station Staff of the Louisiana State University on March 5, on the subject: "Values of a Statistical Laboratory to Experiment Station Workers." He also visited with the University administrative officials concerning future statistical services at L.S.U.

Edgar M. Jacobs has resigned his position as Statistical Specialist with General Foods Corporation in order to accept a position as Mathematician with Caywood-Schiller Associates in Chicago. Caywood-Schiller Associates is a consulting firm specializing in military and industrial operations research.

Charles H. Joseph, Jr. has been named director of all research activities carried on at American Greetings Corporation of Cleveland, Ohio. In his new position he will direct market and consumer research, as well as operations research.

Eugene H. Lehman, Jr., Assistant Professor of Statistics, Mathematics Department, University of Florida, has accepted a position as Dynamics Engineer, Operations Analysis Section, Bell Aircraft, Niagara Falls, New York—a permanent position beginning June 1.

J. William Lloyd is now employed as Statistician (Health and Medicine) with the National Cancer Institute, Bethesda, Maryland.

Carl E. Marshall returned last fall to his position as Professor of Mathematics and Director of the Statistical Laboratory at Oklahoma A & M College. He was granted the Ph.D. degree by Iowa State College in December. His dissertation was entitled: "Cost Control of Sample Surveys by Two-Step Designs."

James J. Maslowski has resigned from the Department of Sociology at Southern Illinois University to accept a position with the Air Force Personnel and Training Research Center at Lackland Air Force Base, San Antonio, Texas. His new duties consist of working as a statistician with the Manpower Research Branch of the Personnel Laboratory.

Thomas J. McCleneghan has left the City-County Planning Department, Tucson, Arizona, to take a position with the Bureau of Business Research, College of Business and Public Administration, University of Arizona, Tucson.

Richard S. Melton formerly Research Psychologist, Air Force Personnel and Training Research Center, San Antonio, Texas, is now Assistant Professor, Psychology Department, Southern Illinois University, Carbondale, Illinois.

Henry S. Miller has been promoted to the rank of Professor of Economics at Queens College, Flushing, New York.

Jack Moshman has joined the Council for Economic and Industry Research, Inc., Washington, D. C., as Director of the Mathematical and Statistical Services Division. He formerly was associated with the Bell Telephone Laboratories, Murray Hill, N. J. as a statistician.

K. R. Nair has been elected a Fellow of the National Institute of Sciences of India.

Lillian Palenius has left her position as Analytical Statistician at the Human Nutrition Research Branch of the Agricultural Research Service to work for the New York Regional Office of the U. S. Public Housing Administration.

Louis J. Paradiso, Assistant Director and Chief Statistician of the Office of Business Economics, was given a special award of $500 in January by the Department of Commerce in recognition of contributions of major value and sustained superior accomplishment.

Joseph S. Rhodes has resigned his position as Methods and Operations Research Officer with the Chesapeake & Ohio Railway Company, Cleveland, Ohio, to accept a position as Manager of Operations Research, Economic Evaluation Department, Atlas Powder Company, Wilmington, Delaware.

Richard S. Ringheim has been appointed by Foster D. Snell, Inc., an organization of consulting chemists and chemical engineers, as its Director of Marketing and Economic Research. In his new position, Mr. Ringheim's duties will include organizing and writing major market and technical surveys for the chemical and related industries.

O. K. Sagen has transferred from the State of Illinois Department of Public Health to the National Health Survey Program, U. S. Public Health Service. His

position is to head up special studies for the Program.

S. Frederick Seymour, formerly of the Sociology Department of the University of Kansas City, is now Assistant Social Scientist in System Development Division, the RAND Corporation, Santa Monica, California.

George W. Snedecor will be a visiting professor in the Institute of Statistics, North Carolina State College, until September 1957. He is engaged in consulting and teaching statistical methods.

David S. Stoller, formerly at The RAND Corporation, is now a member of the Technical Staff of the Ramo-Wooldridge Corporation in the Computer Systems Division.

George W. Summers has left the Prudential Insurance Company of America to take a position as Research Associate with the Operations Research Group at Case Institute of Technology in Cleveland, Ohio.

Robert S. Weinberg has resigned from the Operations Evaluation Group, Massachusetts Institute of Technology and has joined the staff of the Advance Product Planning department, International Business Machines Corporation. He has recently been elected a Fellow of the Operations Research Society of America.

Phillip W. Wenig has accepted the position of Research Executive with National Analysts, Inc. His work will be primarily concerned with the field of mass media and of the audiences reached by each with emphasis on their differential characteristics and motivations.

William H. Williams received an M.S. degree in statistics at Iowa State College last December and is continuing graduate study in statistics there under a fellowship of the Ontario Research Foundation. His master's thesis concerned "Post stratification estimates for multistage samples."

Jo Brice Wilmeth has recently been appointed Survey Statistician in the Transportation Section, Marketing Research Division, Agricultural Marketing Service.

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CHAPTER NOTES

Albany

The speaker at the February 20th meeting was Marvin Hoffenberg, Director of Research, Economic Consulting Department, de Vegh and Company. Dr. Hoffenberg, who was formerly Assistant Chief of the Division of Interindustry Economics of the Bureau of Labor Statistics, spoke on "Input-Output Analysis of the U. S. Economy."

"What Every Statistician Should Know about Electronic Computers" was the subject of the meeting on March 20th. Milton J. Bass, Assistant Director of Unemployment Insurance Accounts, New York State Department of Labor, was the speaker.

Boston

"How to Choose an Electronic Computer" was the subject for a panel discussion at the February 5th meeting of the Boston Chapter. Mr. W. W. K. Freeman, of the Mutual Boiler and Insurance Company, organized the panel which was led by Dr. John Alman, of Boston University. The other speakers were Dr. Leslie Peck, of Arthur D. Little, Inc.; Mr. William Marzo, of William Carter Company; Mr. Giulio Correa, of American Mutual Liability Insurance Company; Mr. Benjamin W. Taunton, of the First National Bank of Boston; and Mr. Harold F. Hatch, of John Hancock Mutual Life Insurance Company. Discussants sketched some of the problems and procedures involved in choosing an electronic computer, including use of outside consultants versus staff committees to make the initial study, length of time required for the initial study, importance of giving all manufacturers a uniform statement of the problem, desirability of considering first the largest computer which the company or organization might use and working from there down to the smaller machines, importance of putting accounting functions (using accounting in the broad sense) on the computer first, and many other factors which enter into the consideration of electronic computers.

Buffalo-Niagara

Major General Leslie E. Simon, Director of Research and Development of the Carborundum Company in Niagara Falls spoke at the January meeting which was held jointly with the American Society for Quality Control. Gen. Simon spoke on the topic "Further Observations on Initiating Quality Control Groups in an Existing Organization", a review of some of his recent experiences in setting up a quality control program.

At the February meeting, Dr. Warren Winkelstein, Special Research Fellow, National Heart Institute, from the Roswell Park Memorial Institute in Buffalo, reviewed some of the statistical studies of heart disease. Investigations of the relationship between heart disease and fat consumption, exercise and smoking were discussed from a statistical and epidemiological point of view. The meeting was held jointly with the Epidemiological Society of Western New York.

Central Indiana

The Chapter's February meeting was held at Butler University. The Chapter President, Dr. Virgil L. Anderson, Director of Purdue's Statistical Laboratory, was the speaker. His topic was, "Seeking Regression Models by Using a Digital Computer."

Dr. Anderson outlined the program for a Datatron which yields the important correlation and regression estimates for large sets or subsets of variables and observations. Such a program and computer are of very great assistance when the end of regression analysis is the discovery of a model which meets some criterion of goodness of fit rather than the more traditional end of simply testing a single hypothetical model. Dr. Anderson also discussed, for orthogonal designs, an analysis of variance technique which can be used to determine from the data the power and interactions of the variables to be used to best explain the data.

Central New Jersey

At the meeting held on February 11th the speaker was Mervin E. Muller, Research Associate at the Statistical Techniques Group, Princeton University. Dr. Muller's subject was "Monte Carlo Applications to Statistics and Numerical Analysis."

Chicago

A dinner meeting was held on February 20th at which the speaker was Milton Friedman, Professor of Economics at the University of Chicago. Professor Friedman spoke on "The Relationship Between Consumption and Income," presenting a new approach which he has developed and discussing the statistical work underlying his investigations.

The luncheon meeting of January 24th heard Dr. Edward J. Taafe, Professor of Geography at Northwestern University, discuss "Use of Maps in Air Transportation Study." At the February 5th luncheon meeting James R. Hawkinson, Professor of Marketing at Northwestern University, spoke on "Marketing in Europe", describing some of his personal experiences. The subject of the luncheon meeting held on February 21st was "Automation and Statistics", and the speakers were Nicholas A. Thermos and John Pensock of the Remington Rand Division of Sperry Rand Corporation. Harry V. Roberts, Associate Professor of Statistics at the University of Chicago and a member of the Chicago Chapter, spoke at the March 5th meeting on "Use of Statistics in Marketing Research."

The fourth Annual Mid-West Conference was held on March 16th at Abbott Hall on the Chicago Campus of Northwestern University. The conference was sponsored by the Chicago Chapter of ASA and the Business Research and Statistics Committee of the Chicago Association of Commerce and Industry, with the cooperation of the Business and Economic Statistics Section of the ASA, the American Economic Association, the American Marketing Association, and the American Society for Quality Control. The subject this year was "Piercing the Communication Barrier with Statistics." The program included sessions on communication through the medium of charts and visual aids, applying graphical techniques to the solution of statistical problems, the relation of the research worker and the managerial genius in making management decisions, harnessing statistical theory to the solution of business problems, conveying results of testing and analysis of consumer products to a non-technical consumer audience, and the problem faced by business publications in translating technical facts and concepts into interesting copy for their readers.

Cleveland

The third luncheon meeting of the 1956-57 season was held on November 27th. Dr. Richard J. De Gray, Product Section Supervisor, Manufacturing Department, Standard Oil Company of Ohio, addressed the group on the subject "Some Smelling Statistics." Dr. De Gray's discussion centered on the evaluation of odors of different batches of mineral spirits and solvents. Of particular interest was his explanation of the application of two experimental designs to organoleptic testing. These designs were modifications of a Youden 7 x 4 balanced incomplete block and the Youden-Hunter Partially Replicated Latin Square. The applications were illustrated in terms of the testing of the odor of petroleum solvents. With a scale of "bad" to "good" rated from zero to ten, a panel of seven judges achieved a confidence limit on such ratings of $\pm$ one unit.

The fourth luncheon meeting of the 1956-57 season was held on January 22nd. Dr. Robert De Baun, Group Leader, Mathematical Analysis Group, Stamford Research Laboratories, American Cyanamid Company, spoke on the subject "Some Examples of Multivariate Analysis." Dr. De Baun stressed the necessity of the multivariate approach to experimental design for the reason that separate responses are rarely completely independent. He dealt with the generalization of the analysis of variance through tests of the null hypothesis. In this way probabilities of the mean squares ratios of effect to error under

the null hypothesis may be calculated.

Two examples were given to illustrate the effectiveness of this approach. One related a bivariate test of significance on two testing laboratories' evaluation of five batches of material. From this type of analysis it was concluded that interlaboratory differences existed and a search for possible origins of difference was recommended. The second example involved a bivariate regression of four variables in a catalytic high pressure system. Data fitted to a full second order model indicated that the regression of variables Y_1 and Y_2 when plotted as a contour map had different surfaces. The two systems were tested in the multivariate sense and the responses were determined jointly significant. The interdependency of Y_1 and Y_2 was tested and the univariate ratios calculated. This test confirmed an initial belief that Y_1 was the major response and Y_2 of only secondary importance.

Denver

A workshop meeting was held January 24th on "Linear Programming and Computing Machines." Walter W. Varner, head of the Flight Simulation Laboratory at Convair Astronautics, was the speaker. Mr. Varner discussed the operation of analog and digital computers, enumerating the advantages of each for general and statistical work. He described the function performed by linear programming as the conversion of physical situations into mathematical equations and finding the best possible solution or combination of variables. He discussed the techniques used to handle the onerous task of trying all the combinations, and gave some illustrations.

The dinner meeting held on February 28th was the third in the Chapter's series on statistics in the professions. Mr. Loren W. Crow, Consulting Meteorologist, discussed statistics in meteorology. Mr. Crow's talk was preceded by a short business meeting.

Detroit

Roger Crane, manager of research management sciences for Touche, Niven, Bailey and Smart, was the speaker at the meeting held February 20th at the University of Detroit. Mr. Crane spoke on "Mathematical Approaches to Management Decisions." Dr. Arvid W. Jacobsen, director of Wayne State University's Computation Laboratory, was guest chairman.

Hawaii

The new 1957 officers of the Hawaii Chapter are

President — Raymond Franzen, Hawaiian Pineapple Co., Ltd.

First Vice-President — Charles F. Congdon, University of Hawaii.

Second Vice-President—Gordon Frazier, Bank of Hawaii.

Secretary-Treasurer—Louisa Franzen, Consultant.

Montreal

At the meeting held on January 8th, the guest speaker was Dr. O. M. Solandt, Assistant Vice-President, Canadian National Railways, who spoke on the history and methods of operations research. Dr. Solandt outlined the typical steps in an OR study and illustrated them with numerous examples from his wartime experiences with the British Operational Research Group. He reviewed the techniques commonly employed and discussed the qualities which, in his opinion, suited a person for OR work. Dr. Solandt concluded his talk with a comparison of operations research in military and industrial situations.

On February 19th, Mr. Harold F. Dodge, of Bell Telephone Laboratories, spoke to the Chapter on "Sampling in Quality Control Work." By asking members present to select a small sample from a container with discs of two colors, Mr. Dodge demonstrated the problem confronting an inspector in checking quality by sample methods. He described the basic tools used by the quality control technician, and illustrated with slides the possible applications of quality control using standard techniques or variations of them.

Also in February, the first meeting of an informal discussion group was held. Prof. Jacques St. Pierre, of the University of Montreal, opened the meeting by discussing a recent problem in regression analysis, and outlined the computational procedures used and some of the difficulties and pitfalls encountered. The balance of the meeting consisted of a general discussion of the problem and others related to it.

New York

The Biostatistics Section sponsored a dinner on January 10th at the Beekman Towers Hotel in honor of Dr. and Mrs. A. Bradford Hill. Dr. Hill is Professor of Medical Statistics at the University of London and a former President of the Royal Statistical Society. He was in the United States as Statistical Consultant for the National Foundation for Infantile Paralysis. More than 100 people attended the dinner, which was preceded by a cocktail hour. Dr. John Fertig, Professor of Biostatistics at the Columbia School of Public Health, was the principal speaker. He related some of his experiences in teaching statistics to medical students in the United States and in South America.

"Money-Flows" was the subject of a meeting held on January 22nd. The speakers were Stanley J. Sigel, in charge of the Money-Flows Section of the Research and Statistics Division of the Board of Governors of the Federal Reserve System, and Kenneth Wright, Economist, Life Insurance Association of America. Mr. Sigel described the history and development of money-flows systems, and Mr. Wright dealt with the use of money-flows in forecasting.

The Social Statistics and Statistical Techniques Divisions of the Chapter held a meeting on February 14th at which Dr. Julius A. Jahn, Community Service Society of New York, spoke on "Statistical Problems and Methods in the Experimental Development of a Health and Welfare Program for the Aging." Robert R. Bush, Professor of Applied Mathematics, Columbia University, was the discussant.

Philadelphia

Dr. Herman Wold, Professor of Statistics at the University of Uppsala, Sweden, was the speaker at the December meeting of the Philadelphia Chapter. The topic was "Demand Analysis: A Survey of Problems, Results, and Methods." Dr. Wold reviewed the history of demand analysis, noting the considerable lag between developments in theory and subsequent empirical studies in this field. He cited demand analysis as one of the first fields in economic theory where methods of causal inference have been adapted to observational data, and followed this with a discussion of the techniques used and the problems encountered in such an approach.

Dr. Wold is visiting the United States under the sponsorship of the Rockefeller Foundation to study new developments in econometrics.

The speaker at the January meeting was Mr. William Hodgkinson, Jr., Supervising Statistician of the American Telephone and Telegraph Company, and the topic, "Population, Economics, and Business." Mr. Hodgkinson discussed the significance of population statistics to business, stressing particularly the implications of population movements and changing age composition for marketing and investment. His remarks were illustrated with a wide variety of slides showing graphically the results of studies of migration, birth and death rates, and family formation.

State College, Pa.

The following officers have been elected for the year 1957:

President—Hans Panofsky, Dept. of Meteorology, Penn State

Vice-President—J. C. Griffiths, Dept. of Mineralogy, Penn State

Secretary-Treasurer — William Ray, Dept. of Psychology, Penn State

The chapter has held three meetings since the beginning of the fall season. On October 22nd, Ruth Silva of the Department of Political Science, and Evan Johnson of the Department of Mathematics, Penn State, discussed "Factor Analysis Prediction of Congressional Elections." On November 30th Churchill Eisenhart of the National Bureau of Standards spoke on "Canons of Sound Experimentation." The January 22nd meeting was devoted to "Computers and Regression Analysis," the speaker being Romauld Slimak, Sperry-Rand Corporation.

During the last year the chapter has sponsored two series of weekly seminars. The subjects were "Analysis of Variance" in the spring of 1956, and "Regression Analysis" last fall.

Southern California

At the dinner meeting of February 28th the speaker was Wilbur E. McCann, formerly Manager of the Research Committee of the Los Angeles Chamber of Commerce and now associated with Facts-Consolidated, an independent research organization. Mr. McCann's subject was "The Effect of the Chamber of Commerce Statistical Program on the Growth of Los Angeles."

The subject of the March 28th dinner meeting was "Statistics and Criterion Data." Mr. Lee Stockford, Corporate Industrial Relations Advisor, Lockheed Aircraft Co., was the speaker.

Tulsa

New officers for the year 1957 are:

President — LYNDRAL MARCUM, Blue Cross Plan

Secretary-Treasurer — DR. MARSHALL MILLIGAN, University of Tulsa

Continuing officers are Richard N. Warwick, First Vice-President in charge of programs, and James B. Lindberg, Second Vice-President in charge of membership.

Washington, D. C.

The chapter held its annual dinner meeting on January 28th at the Occidental Restaurant. The speaker was Raymond T. Bowman, Assistant Director for Statistical Standards, Bureau of the Budget. Dr. Bowman's address on "Improvement of Federal Statistics" is published elsewhere in this issue. The chairman of the meeting was Grover W. Ensley, Executive Director, Joint Economic Committee.

The topic of the February 18th meeting was "Review of Some Recent Developments in Statistical Methods." Dr. W. S. Connor, Statistical Laboratory, National Bureau of Standards, spoke on "Techniques and Rationale of Multiple Comparisons," and Professor W. H. Kruskal, Committee on Statistics, University of Chicago, discussed "Non-parametric Correlations." Dr. Max Halperin, National Institutes of Health, was chairman.

Statisticians

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